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[研究文章 Research Article]

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On the First Record of *Erebus crepuscularis* (Linnaeus, 1758) in Lanyu and Green Island (Lepidoptera, Erebidae, Erebinae)

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Abstract. The *Erebus* Latreille, 1810 populations of Lanyu and Green Island are confirmed to represent a new recorded species, *Erebus crepuscularis* (Linnaeus, 1758) in the present study. Specimens of both sexes and their genitalia are illustrated and compared with that of the widely distributed Oriental species *Erebus ephesperis* (Hübner, 1827).

Keywords: Fauna, Wallace's Line, Oriental region, *Smilax*, Smilacaceae

Introduction

The genus *Erebus* Latreille, 1810 contains about 40 species ranging in the Indo-Australian region (Poole, 1989). According to the faunistic checklist documented in Sugi (1992) and Heppner (2012), 6 species in total are distributed on the main island Taiwan. The *Erebus* populations of Lanyu and Green Island have previously been identified as *E. ephesperis* (Hübner, 1827) by Yang (2000) and Fu & Hsu (2009), respectively. Due to the subtle appearance differences of the examined specimens among Taiwan, Green Island as well as Lanyu. The present study intends to confirm the species identity of these two populations.

Materials and methods

The specimens were examined or borrowed from the following institutions:
CCMF Collection of Chien-Ming Fu, Taichung;
NMNS National Museum of Natural Science, Taichung;
TFRI Insect collection of Taiwan Forestry Research Institute, Taipei.

Genitalia preparations for morphological studies

Genitalia were prepared following the general method described, e.g., by Holloway et al. (1987) with slight modification. After maceration of the abdomen in 10% KOH and subsequent cleaning, male genitalia were carefully removed from the abdomen and abdominal segments 1–8 were opened along the caudocephalic axis from the right side. Female genitalia were removed entirely from the abdomen, cleaned and mounted ventral side up. All the membranous genital tubes and bursae derived from the genital openings were preserved. Genitalia and abdominal skins of both sexes were stained with pen ink (Pilot), preserved in 70% ethanol then transferred in 99.5% ethanol before mounting in Euparal on slides. Specimens were photographed using a Nikon D600 digital camera and slides were photographed using a Nikon D500 digital camera with flash.

Results

***Erebus crepuscularis* (Linnaeus, 1758)**

目裳蛾

(Figs 1–3, 5, 6, 7, 9)

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Phalaena (*Noctua*) *crepuscularis* Linnaeus, 1758, *Syst. Nat.* (Edn 10) **1**: 509
Nyctipao leucotaenia Guenée, 1852, *Hist. nat. Ins., Spec. gén. Lépid.* **7** (Noct. 3): 184
Nyctipao dentifascia Walker, 1865, *List. Spec. Lepid. Insects. Colln. Br. Mus.* **33**: 947
Nyctipao crepuscularis: Moore, 1878, *Proc. Zool. Soc. Lond.* **1878** (4): 849.
Nyctipao dentifascia obscura Bethune-Baker, 1906, *Novit. Zool.* **13**: 250.
Erebus leucotaenia ab. *subobscura* Rothschild, 1915, *Novit. Zool.* **22** (2): 211.
Erebus saparaea Swinhoe, 1918, *Ann. Mag. Nat. Hist.* (London) (9) **2**: 84.
Nyctipao albicrustata Prout, 1919, *Ann. Mag. Nat. Hist.* (London) (9) **3**: 170.
Erebus speciosus Hulstaert, 1924, *Ann. Soc. Ent. Belg.* **64**: 91.
Nyctipao meforensis Prout, 1924, *Bull. Hill. Mus.* **1**: 436, pl. 14, f. 1.
Nyctipao phaea Turner, 1933, *Trans. R. Soc. S. Aust.* **57**: 164.
Erebus ephesperis: Chen, 1999: 1020, pl. 51: 1; Fu & Hsu, 2009: 55, pl. 8: 25; Yang, 2000: 23, *nec* Hübner, 1827

Specimens examined. TAIWAN. 1♀, Taitung County, Green Island, Fire-Burned Hill, 185 m, 6. IV. 2008, leg. C. M. Fu (CCMF); 1♀, same collecting locality, 21. VI. 2008, leg. C. M. Fu (CCMF); 1♀, Taitung County, Fire-Burned Hill, 270m, 22. VI. 2008, leg. C. M. Fu; 1♀, Taitung County, Fire-Burned Hill, 260m, 23. VI. 2008, leg. C. M. Fu. (CCMF); 1♂, Taitung Lanyu, Tianchr No.1, 24-26. IX. 1998, leg. H. T. Shih (NMNS); 3♂♂1♀, same collecting locality, 28. IV-1. V. 1999 H. T. Shih (NMNS); 1♀, Taitung Lanyu, Tianchr No. 2, 27. IV. 1999, leg. H. T. Shih & C. H. Chang (NMNS); 1♂, same collecting locality, 24-26. IX. 1998, leg. H. T. Shih & T. J. Chen (NMNS); 2♂♂, same collecting locality, 24-27. X. 2000, leg. M. M. Yang & H. T. Shih (NMNS); 2♂♂, Taitung, Lanyu, Younghsing No. 4, 26-29. I. 1999, leg. H. T. Shih (NMNS); 4♂♂1♀, same collecting locality, 27-29. VI. 1999, leg. H. T. Shih, slide NMNS ENT3209-280♀ (NMNS); 6♂♂, same collecting locality, 24-27. X. 1999, leg. M. M. Yang & H. T. Shih (NMNS); 1♂, Taitung, Lanyu, Younghsing, 28-29. II. 2000, leg. W. L. Lin & M. F. Lou (NMNS); 1♂, [Taitung Co.], Lanyu Is., Weather St., 5. III. 1991 leg. H. Y. Wang (NMNS); 1♀, [Taitung Co.], Lanyu Is., Lighthouse, 14. XI. 1990, leg. H. Y. Wang (NMNS); 1♂, same collecting locality, 4. III. 1991, leg. H. Y. Wang (NMNS); 2♀♀, [Taitung Co.], Lanyu Is., Yeongshing Farm, 30. VIII. 1990, leg. H. Y. Wang (NMNS); 1♂, Lanyu, Yunshin Farm, 4. IV. 2018, leg. C. H. Ma (TFRI); 1♂, Lanyu, Datienchi, 6. IV. 2018, leg. C. H. Ma (TFRI).

Taxonomic notes. The lectotype of *Phalaena crepuscularis* Linnaeus, 1758 was illustrated by Mikkola & Honey (1993: fig. 12).

Diagnosis. The general appearance of *Erebus crepuscularis* is very similar to that of *E. ephesperis* (Figs 4, 8, 10) but it is darker and larger (wingspan ca. 85 mm rather than ca. 80 mm). These related species represent the only members of this genus that have the slender, flattened uncus (Holloway, 2005). Most females of *crepuscularis* have white transversal medial band on both wings but this character is absent in males. Both sexes of *E. ephesperis*, showing less sexual dimorphism as commented by Holloway (2005), have medial band on both wings. In the male genitalia, the sacculus process is wider with obtuse apex rather than narrow with tapered apex; the presence of one cornutus rather than two cornuti. In the female genitalia, the larger and more elliptic appendix bursae rather than smaller and round one; the elongate, narrower corpus bursae rather than short and wide one.

Distribution and bionomics. Indonesia, the Philippines, Australia; Green Island and Lanyu (new records). The populations in Green Island and Lanyu Island occur throughout the year except in May and August based on the examination of available voucher specimens. Yang (2000) gave the host plant information of Lanyu's *Erebus* (misidentified as *E. ephesperis*) as the family Smilacaceae. Though all known *Erebus* species are specialized on this plant family, the immature stage and actual host plant of this species are still waiting for investigation.

Remarks. Chen (1999) incorrectly recorded *E. ephesperis* as "*E. crepuscularis* 目裳蛾" in China. Apart from this misidentification, we still follow the given Chinese recommended name of Chen's (1999) "*E. crepuscularis*" since this taxon represents the type species of the genus *Erebus* (目裳蛾屬).

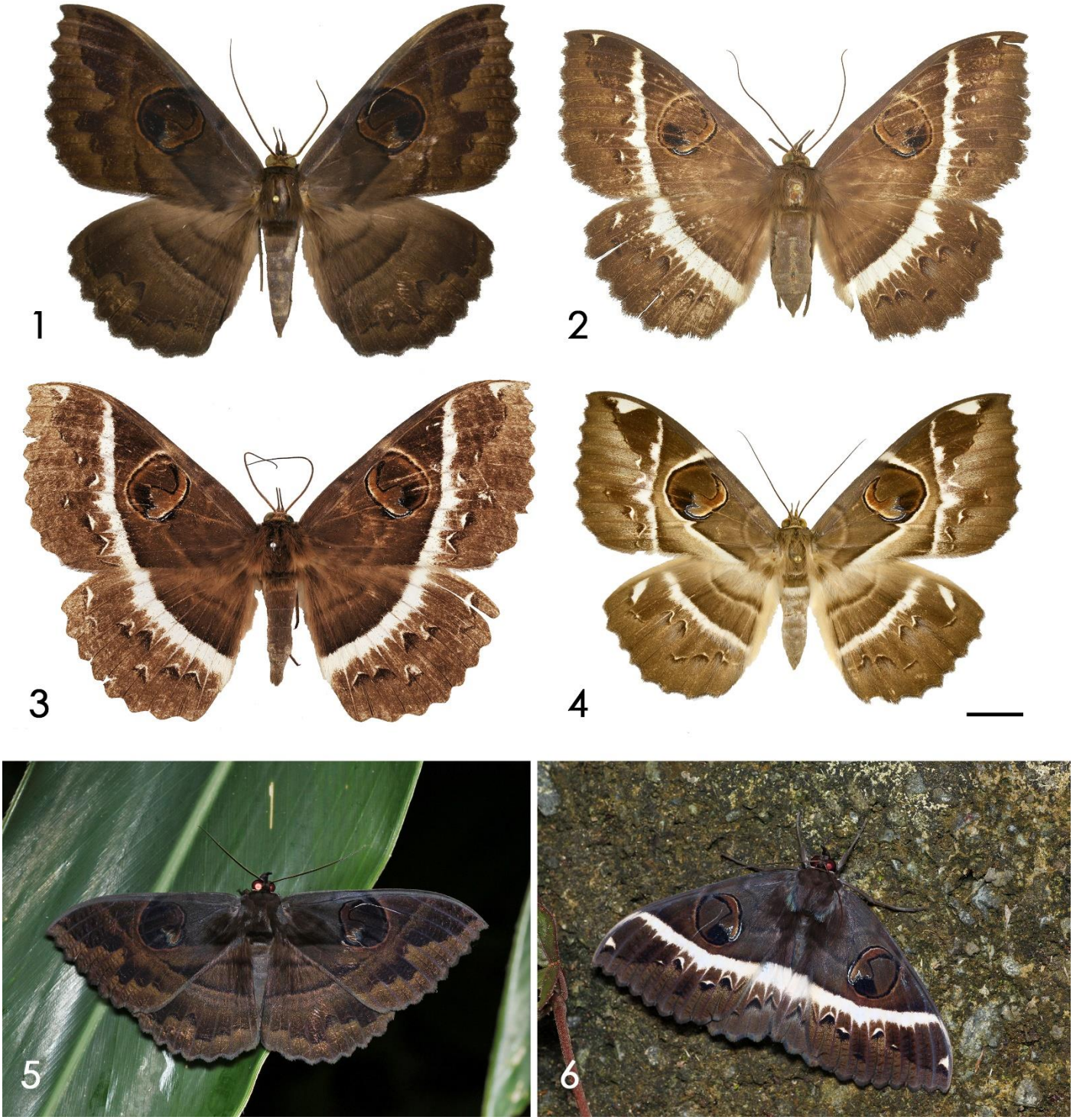

Figure 1–6. Habitus of *Erebus* species. 1–3, 5, 6. *E. crepuscularis* (Linnaeus, 1758), Lanyu; 1, 5. Male; 2, 3, 6. Female; 4. *E. ephesperis* (Hübner, 1827), Taiwan, female. Scale bar= 10 mm. Deposition of specimens: TFRI (1, 4), NMNS (2); CCMF (3). Photo by Shipher Wu (1–4), Cheng-Han Ma.

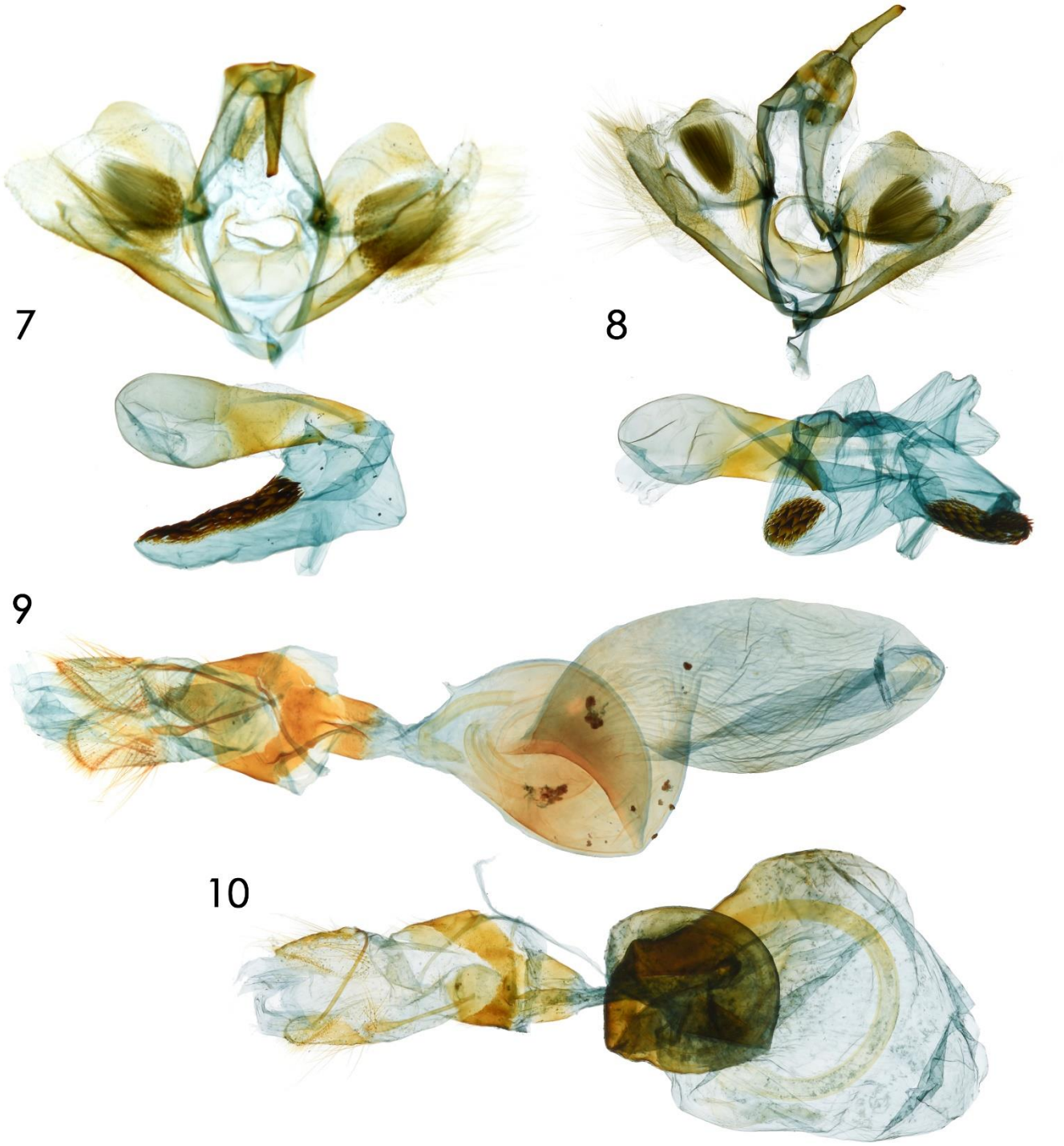

Figure 7–10. Genitalia of *Erebus* species. 7. *E. crepuscularis* (Linnaeus, 1758), Lanyu, male genitalia (TFRI); 9. Ditto, female genitalia (NMNS); 8. *E. ephesperis* (Hübner, 1827), Taiwan (TFRI); 10. Ditto, female genitalia (TFRI). Deposition of specimens: TFRI (7, 9, 10), NMNS (8). Photo by Shipher Wu.

Discussion

The moth faunas of Lanyu and Green Island were earlier investigated by Yang (2000) and Fu & Hsu (2009), respectively. The recent taxonomic reviews, i.e., Sato et al. (2011), Owada & Fu (2020), Owada (2021), revealed the identifications of species distributed in these two islands can be re-evaluated since some species are externally similar to those on the adjacent islands, i.e., Taiwan, Okinawa Islands and the Philippines were misidentified, as the situation reported in the present study. The study of the faunistic differences and causes of the moths on both sides of the so-called “New Wallace Line (Kano, 1941)” will depend on more systematic and solid taxonomic studies in the future.

Acknowledgments

We would like to express our sincere thanks to Ming-Lung Jeng, Mei-Lin Chan, Huei-Hong Liang (NMNS), Jung-Tai Chao, Shen Shan Lu, Yun-Yin Yeh, Ling-Mu Chuan, Yi-Chien Lin (TFRI) who provided great help in the study of the collections of their institutes or museums; to Bin-Hong Ho (National Chung Hsing University=NCHU) for the help of collecting; to Man-Miao Yang, Fang-Shuo Hu (NCHU) for providing references. Last but not least, we would like to express our hearty thanks to two anonymous reviewers for reviewing our manuscript and providing valuable comments.

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目裳蛾（*Erebus crepuscularis* (Linnaeus, 1758)）在蘭嶼與綠島的首次紀錄（鱗翅目：裳蛾科：裳蛾亞科）

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摘要：蘭嶼與綠島產目裳蛾屬 (*Erebus* Latreille, 1810) 族群於本研究證實為新紀錄種目裳蛾 (*E. crepuscularis* (Linnaeus, 1758))。其雌雄標本與生殖器圖示，並與東方區廣布種 (*E. ephesperis* (Hübner, 1827)) 作比較。

關鍵詞：生物相、華萊士線、東方區、菝葜屬 (*Smilax*)、菝葜科 (Smilacaceae)

[研究文章 Research Article]

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First Record of the Lace Bug Genus *Dulinius* Distant (Hemiptera: Heteroptera: Tingidae) from Taiwan

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Abstract. The lace bug genus *Dulinius* Distant, 1903 is native to the Afrotropical and Oriental Regions, whereas only a single species, *D. conchatus* Distant, 1903, has been recorded in the Oriental Region. This species invaded Japan proper, which is located in the Palaearctic Region, at the end of the 20th century. *Dulinius conchatus* occurs in China, India, Indonesia (Java Island), Japan (Honshu, Shikoku, Kyushu), Laos, Malaysia, the Philippines (Luzon Island, Negros Island, Palawan Island), Sri Lanka, Thailand, and Vietnam, but has not been recorded in Taiwan. In this study, *Dulinius* and *D. conchatus* are recorded from Taiwan for the first time.

Keywords: alien species, biology, East Asia, Oriental Region, Rubiaceae

Introduction

The lace bug genus *Dulinius* Distant, 1903 (Hemiptera: Heteroptera: Tingidae) comprises 12 species from the Afrotropical and Oriental Regions: *D. bellus* Drake, 1948, *D. burgeoni* Schouteden, 1953, *D. conchatus* Distant, 1903, *D. congruus* Drake, 1953, *D. distinctus* Duarte Rodrigues, 1982, *D. explanatus* Duarte Rodrigues, 1987, *D. fasciatipennis* Linnavuori, 1977, *D. inflatus* Duarte Rodrigues, 1979, *D. kraussi* Drake, 1953, *D. maculatus* Duarte Rodrigues, 1979, *D. pulchrus* (Schouteden, 1916), and *D. unicolor* (Signoret, 1861) (Drake & Ruhoff, 1965; Linnavuori, 1977; Duarte Rodrigues, 1979, 1982, 1987). However, in the Oriental Region, only a single species, *D. conchatus* Distant, 1903, has been recorded from China, India, Indonesia (Java Island), Laos, Malaysia, Philippines (Luzon Island, Negros Island, Palawan Island), Sri Lanka, Thailand, and Vietnam (Drake & Ruhoff, 1965; Péricart, 1986, 1992; Guibert, 2007; Guilbert & Guidoti, 2018; Guilbert et al., 2018). This Oriental lace bug invaded Japan proper (Honshu, Shikoku, Kyushu) located in the Palaearctic Region at the end of the 20th century (Tomokuni & Saito, 1998; Yamada & Ishikawa, 2016) and is a pest of *Morinda tinctoria* Roxb. (Rubiaceae) in India (Dhanasekaran et al., 2008). Therefore, the distribution of *D. conchatus* needs to be monitored to take prompt action when it becomes an alien species or a pest.

Recently, the second author collected an indeterminate species of *Dulinius* from *Paederia foetida* L. (Rubiaceae) in Taipei, Taiwan. After careful morphological examination, the first author concluded that it represents *D. conchatus*. In this study, we recorded *Dulinius* and *D. conchatus* from Taiwan for the first time.

Materials and methods

Dried specimens were used to observe and measure the morphological characteristics under a stereoscopic microscope (SZ60; Olympus, Tokyo, Japan) equipped with an ocular grid. Measurements were obtained using a micrometer on an ocular grid. The specimens were photographed using a digital microscope (Dino-Lite Premier M, Opto Science, Tokyo, Japan), and image stacks were processed using Adobe Photoshop 2021 ver.22.5.1. Photographs of the labels were taken with a compact digital camera (Tough TG-6, Olympus, Tokyo, Japan).

All specimens used in this study are deposited in the Entomological Laboratory Faculty of Agriculture, Kyushu University, Fukuoka, Japan (ELKU), the Kyushu University Museum, Fukuoka, Japan (KUM), and National Museum of Natural Science, Taichung, Taiwan (NMNS).

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Results

Dulinius conchatus Distant, 1903

(Figs 1, 2)

Dulinius conchatus Distant, 1903a: 48. Syntypes, Sri Lanka: Batticaloa; British Museum of Natural History, London, United Kingdom (BMNH).

References. Distant (1903b: 133) (record, habitus, description); Distant (1910: 110) (record, distribution, host); Drake & Ruhoff (1965: 201) (catalog); Péricart (1986: 649) (distribution); Péricart (1992: 48) (distribution); Tomokuni & Saito (1998: 23) (distribution); Pemberton et al. (2005: 81) (record, bionomics, host plant, biological control); Guilbert (2007: 14) (distribution); Dhanasekaran et al. (2008: 147) (pest); Yamada & Yukinari (2009: 53) (record, habitus, distribution); Yamada & Ishikawa (2016: 431) (checklist: Japan); Guilbert & Guidoti (2018: 290) (distribution); Guilbert et al. (2018: 596) (distribution).

Material examined. Non-types (5 ♂♂ 13 ♀♀), **TAIWAN: TAIPEI CITY:** Da'an District, on abaxial surface of leaves of *Paederia foetida*, 25°00'44.8"N 121°32'47.2"E, 5.x.2021, leg. Y.-J. Tsai (7 ♀♀, NMNS). **NANTOU COUNTY:** Shuili Forest Station of National Taiwan University (台灣大學實驗林水里營林區), 23°45'57.9"N 120°51'21.6"E, alt. 404 m, 15.vii.2016, leg. H.T. Yeh, Malaise trap (1 ♂, NMNS); same locality and method, 18.viii.2016 (1 ♂, NMNS); Lugu, NTU Qingshuigou Experimental Forest Station (台灣大學實驗林鹿谷清水溝樹木標本園), 23°45'41.4"N 120°47'33.8"E, alt. 434 m, 2.viii.2016, leg. H.T. Yeh, Malaise trap (1♀, NMNS). **JAPAN:** Kanagawa-ken, Atsugi-shi, Funako, 35°25'58.3"N 139°20'48.6"E, 10.vi.2017, leg. J. Souma (5 ♂♂ 5 ♀♀, ELKU). **MALAYSIA:** Taiping (lowland), 18.viii.1991, leg. S. Kamitani (1 ♀, KUM).

Diagnosis. Recognized among other species of *Dulinius* by a combination of the following characters (Figs 1, 2): rostrum reaching posterior margin of metasternum; hood with 4 rows of areolae at highest part; paranotum strongly reflexed upward, with 4 rows of areolae at widest part; median carina laminate in posterior part and ridge-shaped in remaining parts, with 2 rows of areolae at highest part; lateral carinae combining each other to form a semi-globose, with 3 rows of areolae at highest part; costal area of hemelytron with 3 rows of areolae at widest part; subcostal area with a single row of areolae throughout its length; discoidal area with a single row of areolae throughout its length; and sutural area with 2 rows of areolae at widest part.

Measurements. Taiwanese population (n = 7): body length with hemelytra 3.1–3.4 mm; maximum width across hemelytra 2.0–2.2 mm; pronotal length 1.5–1.7 mm; pronotal width across paranota 1.7–1.9 mm; hemelytral length 2.1–2.3 mm; hemelytral width 1.1–1.2 mm; length of antennal segments I to IV 0.2 mm, 0.1 mm, 0.8 mm, and 0.7 mm, respectively.

Remarks. The seven specimens from Taiwan recorded above (Fig. 1) correspond well to the Japanese and Malaysian specimens (Fig. 2) and the original description (Distant, 1903a) of *Dulinius conchatus* in terms of morphological characteristics. In conclusion, the first author identified Taiwanese specimens as *D. conchatus*.

Distribution. Taiwan (new record); China; India; Indonesia (Java Island); Japan (Honshu, Shikoku, Kyushu) (invaded); Laos; Malaysia; Philippines (Luzon Island, Negros Island, Palawan Island); Sri Lanka; Thailand; Vietnam.

Host plant. *Morinda tinctoria* Roxb. (Rubiaceae); *Morinda* sp.; *Paederia foetida* L. (Rubiaceae).

Bionomics. In Taiwan, *Dulinius conchatus* feeds on the abaxial surface of leaves of *Paederia foetida*, similar to many tingids (Schuh & Weirauch, 2020). Adults were collected in July, August and October in Taiwan.

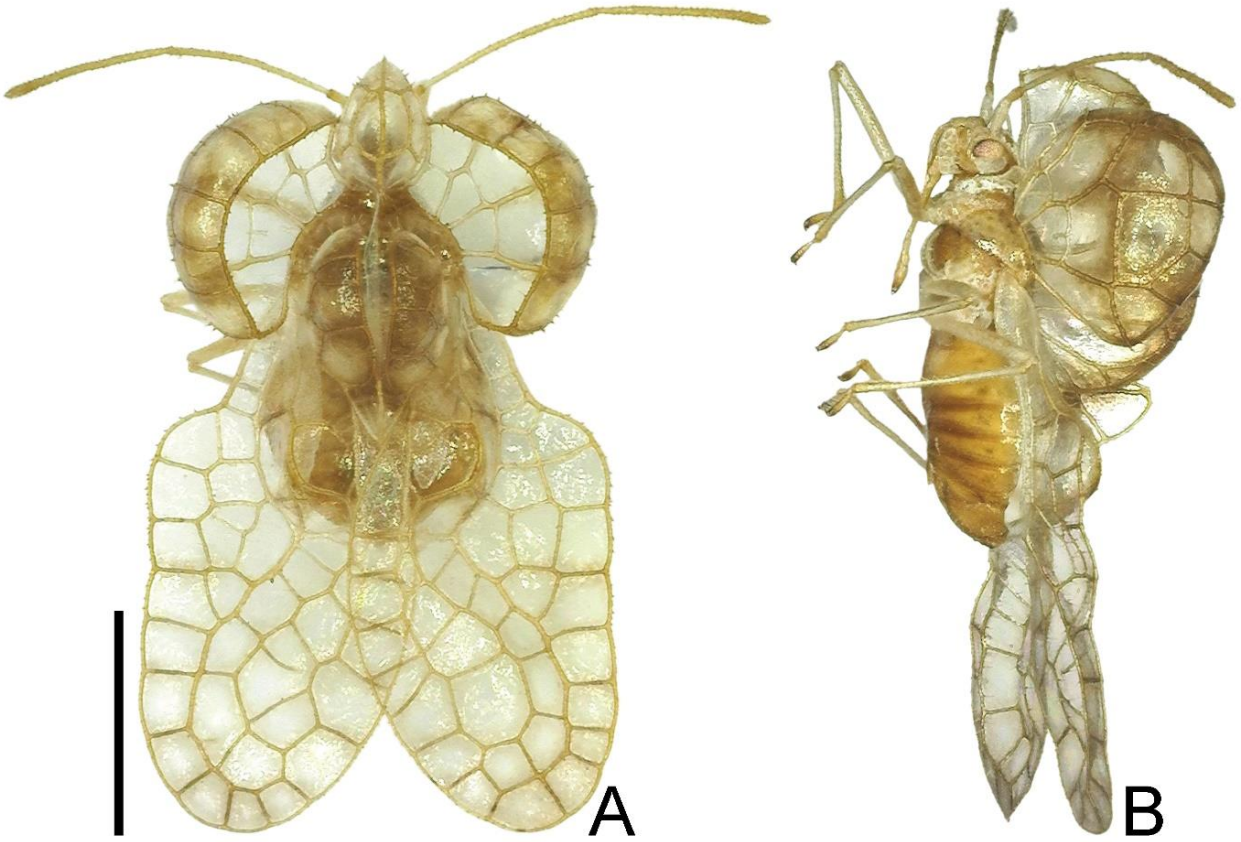

Figure 1. Habitus of *Dulinius conchatus* Distant, 1903 from Taiwan. A: female, dorsal view, B: female, lateral view. Scale bar: 1.0 mm.

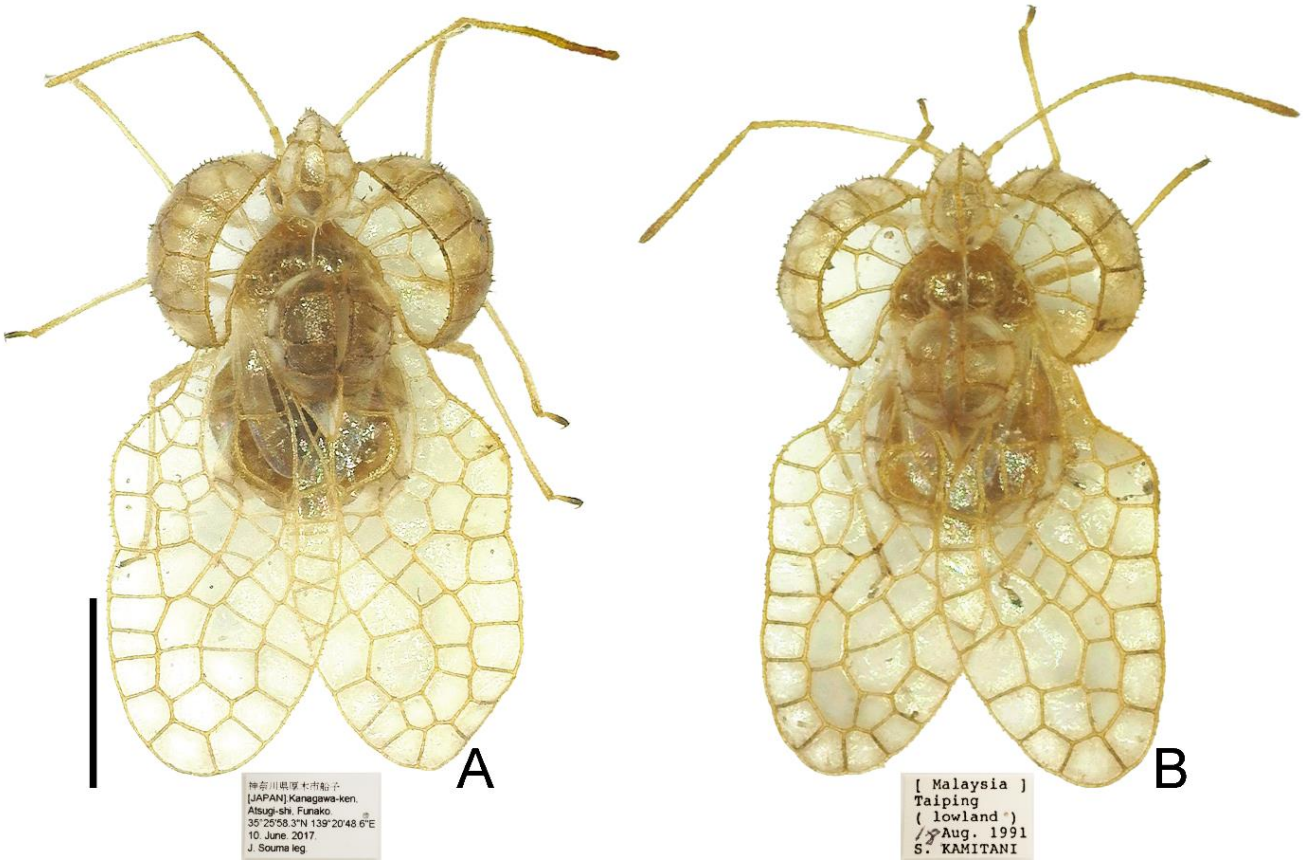

Figure 2. Dorsal habitus and label of *Dulinius conchatus* Distant, 1903. A: female from Japan, B: female from Malaysia. Scale bar: 1.0 mm.

Discussion

Dulinius conchatus is recorded from Taiwan for the first time. It has been collected from *Paederia foetida* in urban areas of Taipei City, whereas no specimen has been found in natural environments to date. Therefore, this lace bug may be an alien species that invaded and expanded its distribution at least a few years ago. We propose further taxonomic and faunistic studies are required to verify the origin of Taiwanese *D. conchatus* and its distribution range in Taiwan.

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臺灣貝肩網蝽屬首次紀錄（半翅目：網蝽科）

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摘要：貝肩網蝽屬 (*Dulinius* Distant, 1903) 已知分佈於舊熱帶區及東方區，東方區僅記錄貝肩網蝽 (*D. conchatus* Distant, 1903) 一種，而該物種於 20 世紀末時入侵位於古北區的日本。至今為止，貝肩網蝽的分布已知有中國、印度、印度尼西亞 (爪哇島)、日本 (本州、四國、九州)、寮國、馬來西亞、菲律賓 (呂宋島、內格羅斯島、巴拉望島)、斯里蘭卡、泰國和越南，而臺灣目前尚無分布紀錄。 本研究提供 *Dulinius* 與 *D. conchatus* 在臺灣的首次紀錄。

關鍵詞：外來種、生物學、東亞、東洋界、茜草科

[科學短訊 Scientific Communication]

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大褐黽蝽於臺灣本島的首次紀錄（半翅目：黽蝽科）

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摘要: 大褐黽蝽 (*Limnometra femorata* Mayr, 1865) 在臺灣的紀錄原僅限於離島的蘭嶼與綠島，本研究首次報導來自於臺灣本島的紀錄。

關鍵詞: 半水棲昆蟲、蘭嶼、綠島、恆春半島、水黽

大褐黽蝽屬 (*Limnometra*) 分布於東方區至澳洲 (Hungerford & Matsuda, 1958)，而臺灣唯一的此屬物種為大褐黽蝽 (*Limnometra femorata* Mayr, 1865)，目前臺灣僅記錄於蘭嶼和綠島 (Hayashi & Miyamoto, 2018)。本種是臺灣黽蝽科 (Gerridae) 中體長第二大的種類，體長最大者則為長翅大黽蝽 (*Aquarius elongatus* (Uhler, 1897))，體長 19–27 毫米 (Hayashi & Miyamoto, 2018)。Miyamoto (1964) 首次提供日本與那國島和綠島的大褐黽蝽紀錄，並預測臺灣本島應涵蓋在分布範圍內。本研究首次發現來自恆春半島的本種標本，證實了 Miyamoto (1964) 的預測。

本研究檢查之標本存放於第一作者收藏 (HCLC: H.-C. Liu collection, Hsinchu, Taiwan) 及國立中興大學 (NCHU: National Chung Hsing University, Taichung, Taiwan)。

大褐黽蝽
***Limnometra femorata* Mayr, 1865**
(圖一 A–G)

標本檢查：TAIWAN: 1♀ (長翅型), Pingtung County, near Maanshan Nuclear Power Plant (第三核能發電廠附近), 1.XII.2018, K.-Y. Zheng leg. (HCLC); 1♀ (長翅型), Pingtung County, Chufeng Mountain (出風山), 26.VI.2020, I.-L. Lee & F.-S. Hu leg. (NCHU); 1♂, 3♀♀ (長翅型), Taitung County, Lanyu (蘭嶼), Dongqing (東清), 27.VII.2021, C.-H. Ma leg. (HCLC, NCHU).

鑑定特徵：大褐黽蝽具有較大的體長 (雄蟲 21–23 毫米，雌蟲 17–19 毫米) 可以輕易與臺灣產大黽蝽屬 (*Aquarius*) 以外的黽蝽科物種區分；本種可以通過以下特徵與大黽蝽屬區分：體色褐色 (圖一 A–B)、前胸側面黑色條紋延長至中胸側面並分開成兩條 (圖一 B)、中足腿節近頂端約 1/8 處呈淡黃色，最頂端黑色，並具有尖銳突出。

生物學資訊：本種於蘭嶼棲息於低海拔，可見於靜止水域及有樹蔭覆蓋之溪流緩流處；屏東出風山的標本採自樹林內的暫時性水域。前人研究推測一年可繁殖數代，3 月至 10 月為主要繁殖期 (Watanabe, 2020)。

分布：臺灣 (蘭嶼、綠島)、日本 (與那國島)、馬來西亞、菲律賓、印度尼西亞 (Hungerford & Matsuda, 1958; Miyamoto, 1964; Hayashi & Miyamoto, 2018)。**新紀錄：臺灣 (恆春半島)。**

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本研究特別感謝鄭楷穎先生及胡芳碩先生 (國立中興大學昆蟲學系) 提供重要的標本與審稿人之寶貴意見。

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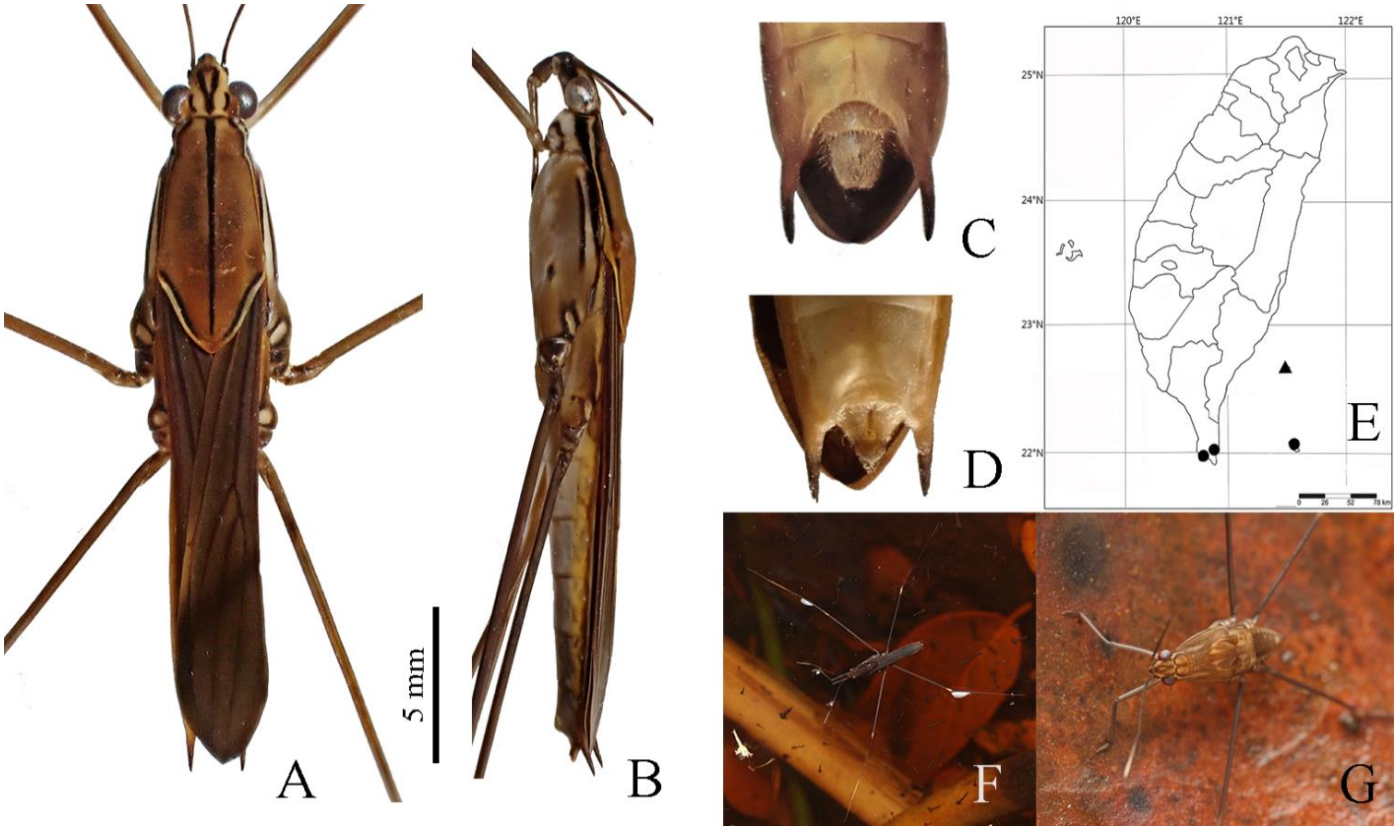

圖一、大褐黽蝽 (*Limnometra femorata* Mayr, 1865)：(A) 成蟲背面照；(B) 成蟲側面照；(C) 雄蟲生殖器腹面照；(D) 雌蟲生殖器腹面照；(E) 本種於臺灣的分布圖 (圓形符號標示本研究中檢視標本之採集地，三角形符號為文獻紀錄之採集地)；(F) 成蟲生態照；(G) 若蟲生態照。

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First Record of *Limnometra femorata* Mayr, 1865 (Hemiptera: Gerridae) in Taiwan Island

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Abstract: Distributional records of *Limnometra femorata* Mayr, 1865 in Taiwan were previously confined to Lanyu Island and Green Island. This study reports the first record of the species from Taiwan Island.

Keywords: semi-aquatic insect, Lanyu Island, Green Island, Hengchun Peninsula, water striders

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